PEDESTRIAN TRAVEL CHARACTERISTICS

Gary E. Maring, Office of Highway Planning, Federal Highway Administration

A survey of pedestrian trips was conducted in Washington, D.C., and supplemented by data from the Nationwide Personal Transportation Study conducted by the Bureau of the Census for the Federal Highway Administration. The major purpose of the Washington survey was to analyze data on walking trip lengths as a function of age, sex, trip purpose, and day of week for use in transportation and community planning. The Nationwide Personal Transportation Study provided supplemental data on walking to work. Results of the Washington survey show that 90 percent of the walking trips were less than 1 mile. This should be considered a maximum distance for any significant walking to community services. The median walking trip length was 1,600 ft. This seems to be a desirable distance in which to provide frequently visited services such as convenience shopping or recreation facilities. Men generally made longer walking trips than women. There were differences in trip length distributions by age group, but the trend was not clear. Trip lengths were the longest for the trip to work. The Nationwide Personal Transportation Study showed shorter trip lengths than the Washington survey for the work trip, with almost 71 percent less than ½ mile. Nationwide, 5 percent of the working population reported walking as the usual method of getting from home to work. There was a higher proportion of persons with incomes under $4,000 walking to work than in those income groups over $10,000. The youngest and oldest working age groups reported higher-than-average walking to work.

•IT IS recognized that more effort in transportation planning should be directed toward reducing vehicular trip demands. Much of our recent residential land use development has forced the necessity for vehicular trips. Segregation of land uses has kept most commercial activity away from residential areas, and thus a car is usually required for convenience shopping. Even for walking enthusiasts, the lack of sidewalks is certainly a discouraging factor.

Consideration of satisfying certain trip demands by walking would seem to be a reasonable goal in transportation studies. As Mumford (1) emphatically puts it,"Every urban transportation plan should put the pedestrian at the center of all proposals. The pedestrian must be treated with respect as we now treat the auto."

The United Nations symposium on planning of metropolitan areas and new towns (2) stated that residential districts should include "those institutions, services, and amenities that are visited by the public frequently . . . such as cinemas, clubs, health clinics, shopping centers, etc. The facilities should be sited within easy walking distance of all dwellings they serve." This is an especially important consideration in apartment and townhouse developments.

A great deal of effort has been devoted to the transportation planning process. A significant portion of resources has been used for origin-destination data collection. These studies have identified the travel patterns of motorists. However, very little effort has been devoted to studies of pedestrians.

To gather some base data for community pedestrian consideration, a survey of residentially based walking trips was conducted. The survey was made in the southwest section of Washington, D.C. The residential areas surveyed consist of large apartment buildings and clusters of townhouses. With this dense residential development and the location of shopping, recreation, and employment facilities in the area, the possibility for a significant number of walking trips exists. Analyses of the pedestrian data are included in this report.

The survey in Southwest Washington is supplemented by data from the Nationwide Personal Transportation Study conducted by the Bureau of the Census for the Federal Highway Administration. Data on those walking to work cross-classified by household characteristics were available.

SOUTHWEST WASHINGTON PEDESTRIAN TRAVEL SURVEY

The major objective of the pedestrian survey was to determine distributions of walking trip distances by day, purpose, age, and sex. Attitudes toward walking and bicycling were also investigated. These data should be important for planning community services for various age groups.

Procedures

The survey was conducted in two residential developments in the southwest area of Washington, D.C. One development was River Park Mutual Homes, a cooperative consisting of two high-rise apartment buildings with 384 units and a group of 134 townhouses. The residents are primarily professionals. The other development, Channel Square, is adjacent to River Park and is a subsidized moderate-income rental complex consisting of a high-rise apartment of 128 units and 75 townhouses.

A sample of one in three households was selected for interviewing in the River Park development. Because of lower response rates in lower income households, it was decided to increase the sample rate in Channel Square to one in two households.

Data were collected for four days, Saturday through Tuesday, to show weekend and weekday characteristics. A pre-sample showed that this was feasible.

Several factors affecting trip length were included in the questionnaire. Trip distances for males and females would be expected to be different because of physical capacity and because of safety considerations. Age was also considered to be an important factor. In order not to force a person to give his specific age, he was asked to indicate his age group. The trip purpose was asked to determine differences in trip length by purpose. The estimated number of blocks for each trip was asked and also the location so the distance could be checked if it was not given. Household data such as number of adults, number of children, and number of automobiles were asked for comparison with trip-making. Factors were indicated that might affect the decision to walk. Attitudes toward bicycling were also asked.

A cover letter and questionnaire were left at each sampled household on Tuesday evening, November 3, 1970, asking for walking trips for the previous four days, Saturday through Tuesday.

With one follow-up letter, the response rate was 35 percent overall. As expected, the response rate from Channel Square was lower than in River Park—25 percent compared to 43 percent.

Results

In all, 294 walking trips were reported from the survey. Figure 1 shows the cumulative trip length distribution of all trips; 89 percent of the trips are less than 1 mile, and 50 percent are less than 1,600 ft.

Walking trip lengths by age group are given in Table 1. A chi-square test of significance was used to check for differences in trip length by age group. The hypothesis tested is that the distributions of trip length are the same for all age groups. Table 2 shows the contingency table for the chi-square analysis. The value of chi square as calculated by the formula $\chi^2 = (O - E)^2/E$ is 20.39. The chi-square value at the 0.05 level of significance with 10 degrees of freedom is 18.3. Therefore, the hypothesis can be rejected. By rejecting the hypothesis, there are only 5 chances in 100 of being wrong. Although the trip length distributions by age are significantly different, the three curves cross over in Figure 2, which indicates no clear relationship between trip length and age.

Table 3 gives the relationship between sex and trip length. As anticipated, male trip lengths were longer than female trip lengths (Fig. 3). A chi-square analysis was used to test the hypothesis that the two distributions were the same. The value of chi square was calculated to be 28.12. Entering the chi-square table with 8 degrees of freedom, it was determined that the hypothesis could be rejected at the 0.005 level of significance. The difference between distributions of trip length made by males and females is somewhat influenced by the relatively long work trips made by men.

Table 4 gives the trip length by purpose. Although there is quite a bit of scatter in the figures, relative trip lengths by purpose can be determined. It must be emphasized that trip lengths by purpose are affected by the location of services in the Southwest area. The shortest trip lengths were to board a mode of transportation outside the development (bus, car, taxi). The longest trips were to work.

Figure 4 shows the trip purpose distribution for all days combined. Shopping represents about half of all trips. The second most frequent trip purpose was outdoor recreation.

Trip purpose by day of week as given in Table 5 shows some interesting results. Three-fourths of all trips on Saturday were for shopping, primarily grocery shopping. Shopping trips on Sunday, Monday, and Tuesday were just over a third of all trips on those days. On both Saturday and Sunday outdoor recreation trips were the second most frequent trips. From the completed questionnaires it was noted that several of these were trips to walk dogs. Work trips were the second most frequent purpose for walking on Monday and Tuesday.

Tables 6 and 7 show trip purpose distributions by age and by sex. The significant difference by age group, as expected, is that those 60 years of age or over had a smaller proportion of work trips. The older age group had a higher proportion of shopping trips than the other age groups. The 18 to 39 age group had the highest proportion of outdoor recreation trips. The trip purpose distribution by sex shows that females made more shopping and personal business trips and that men made more work trips.

Trip production varied little by housing type. For all adults making trips, the average number of trips for the four survey days was 3.1 trips per adult. For households with walking trips, the average number of trips for the four survey days was 4.1 trips per household, but 21 percent of the households had no walking trips. For all households, the average number of trips per household was 3.3 trips.

Vehicle trip productions are often related to family size. To test if there was a difference in walking trip production by family size a chi-square analysis was done. The hypothesis was that number of trips per household was independent of family size. The value of chi square was 3.32. The hypothesis could not be rejected at the 0.10 confidence level. Therefore, it is probable that the number of walking trips is independent of family size.

Respondents, whether or not they walked, were asked to rank those factors that discourage them from walking. The following were listed on the questionnaire: unfavorable weather, crime, lack of adequate sidewalks, heavy automobile traffic, smog or pollution, and other (please specify). According to Table 8, the greatest number of respondents ranked crime as the most significant factor discouraging walking. Written comments indicated that crime was an especially significant factor at night. Many people indicated that they did not walk at all at night because of crime. Unfavorable weather was listed as the most important factor by 24 people as compared to 37 indicating crime; 16 indicated other factors as most significant. These included factors such as distance or time, laziness, lighting, health, and heavy shopping bundles. Three indicated heavy automobile traffic as the most significant.

Bicycling

With the increasing popularity of bicycling among adults, it was decided to assess bicycle use and attitudes toward bicycling for short trips. Only five persons indicated use of a bicycle in the previous week. Interestingly, these persons all lived in River Park. This may indicate that income and occupation have some influence on bicycling.

Figure 1. Pedestrian trip length-frequency distribution.

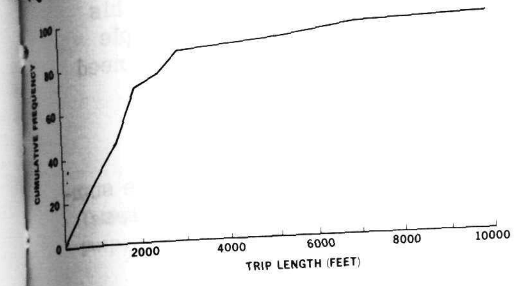


Table 2. Contingency table for chi-square analysis of trip length by age group.

Pedestrian Trip Length (ft)	Number in Age Group						
	18-39		40-49		60 or Older		Total
	O	E	O	E	O	E	O
1-50	16	13.3	22	20.7	3	7.0	41
501-1,000	16	13.6	21	21.2	5	7.2	42
1,001-1,500	9	12.0	18	18.6	10	6.4	37
1,501-2,000	16	22.1	39	34.2	13	11.7	68
2,001-3,000	22	15.6	14	24.2	12	8.2	48
Over 3,000	10	12.3	24	19.3	4	6.4	38
Total	89		138		47		274

0 = observed, E = expected.

Table 3. Pedestrian trip length by sex.

Pedestrian Trip Length (ft)	Sex, Percentage	
	Male	Female
1-500	10.7	18.4
501-1,000	14.5	15.3
1,001-1,500	14.5	12.9
1,501-2,000	22.1	26.4
2,001-2,500	6.9	4.9
2,501-3,000	6.1	14.7
3,001-4,000	0.8	0.6
4,001-5,280	4.6	2.5
5,281-7,000	8.4	3.1
7,001-8,500	2.3	1.2
8,501-10,000	1.5	0.0
10,001-12,500	7.6	0.0
Total	100.0	100.0

Table 4. Pedestrian trip length by trip purpose.

Pedestrian Trip Length (ft)	Trip Purpose, Percentage						
	Work	Personal Business	Shop	Social	Outdoor Recreation	Other	Change Mode
1-1,000	12.1	20.0	32.1	47.4	24.4	7.7	73.9
1,001-2,000	0.0	40.0	54.0	36.8	41.4	11.5	26.1
2,001-3,000	6.1	26.7	13.9	5.3	12.2	61.6	0.0
3,001-5,280	18.2	0.0	0.0	0.0	7.3	11.5	0.0
5,281-8,500	48.4	0.0	0.0	10.5	7.3	0.0	0.0
8,501-12,500	15.2	13.3	0.0	0.0	7.3	7.7	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 1. Pedestrian trip length by age group.

Pedestrian Trip Length (ft)	Age Group, Percentage		
	18-39	40-59	60 or Older
1-500	18.0	15.9	6.4
501-1,000	18.1	15.3	10.6
1,001-1,500	10.1	13.0	21.3
1,501-2,000	18.0	28.4	27.7
2,001-2,500	5.6	6.5	6.4
2,501-3,000	19.2	3.6	19.1
3,001-4,000	1.1	0.7	0.0
4,001-5,280	2.2	5.8	0.0
5,281-7,000	5.5	2.9	0.0
7,001-8,500	0.0	2.9	2.1
8,501-10,000	0.0	1.4	0.0
10,001-12,500	2.2	3.6	6.4
Total	100.0	100.0	100.0

Figure 2. Pedestrian trip length by age group.

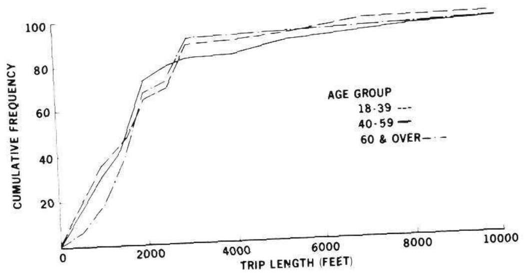


Figure 3. Pedestrian trip length by sex.

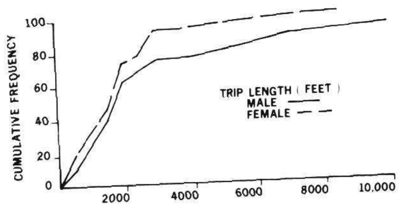
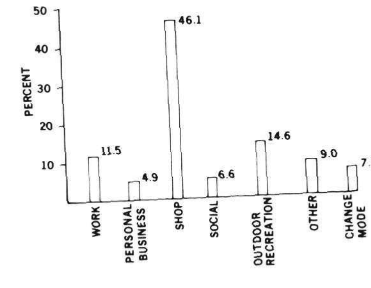


Figure 4. Trip purpose distribution.



The distribution of attitudes toward bicycling for short trips is as follows: 35 people were very favorable; 22, favorable; 12, unfavorable; and 9, very unfavorable. This indicates a generally favorable attitude toward bicycling. However, several people indicated that they were reluctant to ride in the traffic stream. They indicated a need for separate bikeways.

Written Comments on Questionnaires

There were many interesting comments provided by respondents that cannot be summarized neatly in a table but deserve some consideration. Several of the responses follow:

"Potential criminal acts discourage free and open walking."

"Favor bicycling, but there must be safe and convenient bicycle racks at all stores. There must be bicycle paths to stores separated from automobile traffic. You can't cope with packages, a bicycle, traffic, going up and down curbs all at once."

"I can't remember when I've walked last. I have walked to the park but not recently."

"Would like to see walkway developed to the Hill, using the pedestrian underpass—diagonaling up through the Southwest development, with a sidewalk cafe or two. I feel city and construction firms have been very amiss not to prepare walkways through or along construction that blocks 4th Street (shopping center construction). A year or so of walking in the parking lot and across the mud, dust, and dirt of the Methodist Church lawn is most disheartening, hard on shoes, dangerous in parking lot, etc. Many people must feel this."

"I believe strongly with Jane Jacobs that residential areas should not be solely residential. I would like little bookstores, art galleries, fruiterers, bakers, florists, etc., interspersed among townhouse areas, possible marginal operations in people's houses—much more fun that way, more interesting walking, pleasant small expeditions getting people out of their boxes often and easily, leading to sociability."

"Enjoy walking to park but no other place to walk."

"My husband used to walk to work on Capitol Hill, but the lack of adequate sidewalks, deserted fields, dismal atmosphere, and pollution . . . have stopped it."

"Walking and bicycling are good for health and for relieving tension, but you need an inspiring view and a place to move freely."

"I am unfavorable to bicycling with present traffic hazards, but I would be favorable to bicycling if bikeways were provided."

"My bicycle was stolen the last time I used it for transportation, and the problem of potential theft prevents my using my new one for anything except riding around."

"We do not walk any distance except to the car—then drive to work or shop."

"At present my health precludes any extensive walking."

WALKING CHARACTERISTICS FROM NATIONWIDE PERSONAL TRANSPORTATION STUDY

Data from the Nationwide Personal Transportation Study conducted by the Bureau of the Census under contract to the Federal Highway Administration were used to supplement the Southwest Washington survey. The sample consisted of two panels of approximately 3,000 addresses, each distributed throughout the United States. Data from the two panels were combined to provide a broader base for statistical analysis. On the travel-to-work portion of the questionnaire, information was obtained on mode, including walking. Information gathered at the household allows comparison of mode, in this case walking only, with household characteristics such as income and occupation. In addition, the trip length data can provide some comparisons with the data from the Southwest Washington survey. The income and occupation distribution from the Nationwide Personal Transportation Study includes persons working at home or no fixed place. Trip length data exclude these persons.

In the nationwide survey, 5.0 percent of the employed persons 16 years of age and older reported walking as the usual mode of transportation to work. The reported trip length is given in Table 9. Almost 71 percent reported walking less than ½ mile to

Table 5. Pedestrian trip purpose by day of week.

	Day of Week, Percentage				
Purpose	Saturday	Sunday	Monday	Tuesday	All Four Days
Work	2.3	0.0	18.1	23.5	11.5
Personal business	3.5	0.0	7.2	7.4	4.9
Shop	73.2	35.2	36.3	32.4	46.1
Social	7.0	11.8	4.8	4.4	6.6
Outdoor recreation	11.6	29.4	12.0	10.3	14.6
Other	1.2	21.6	9.6	8.8	9.0
Change mode	1.2	2.0	12.0	13.2	7.3
Total	100.0	100.0	100.0	100.0	100.0

Table 6. Pedestrian trip purpose by age group.

	Age Group, Percentage		
Trip Purpose	18-39	40-59	60 or Over
Work	12.4	9.2	4.3
Personal business	5.6	4.9	4.3
Shop	46.1	43.6	63.2
Social	7.9	4.2	8.7
Outdoor recreation	20.2	12.0	13.0
Other	6.7	10.6	6.5
Change mode	1.1	15.5	0.0
Total	100.0	100.0	100.0

Table 7. Pedestrian trip purpose by sex.

	Sex, Percentage	
Trip Purpose	Male	Female
Work	17.4	6.8
Personal business	2.2	7.5
Shop	38.0	42.2
Social	5.4	9.0
Outdoor recreation	15.2	16.5
Other	9.8	10.5
Change mode	12.0	7.5
Total	100.0	100.0

Table 8. Rank of factors that discourage walking.

Rank	Unfavorable Weather	Crime	Lack of Adequate Sidewalks	Heavy Auto Traffic	Smog or Pollution	Other
1	26	37	0	3	0	16
2	24	17	1	6	4	6
3	5	2	6	11	7	2
4	3	3	4	4	6	2
5	1	2	7	2	6	0
6	0	2	3	2	1	0

Table 9. Percentage of persons who walk to work by distance.

Reported Miles to Work	Percent	Cumulative Percent
½ or less	70.8	70.8
1	24.0	94.8
2	4.5	99.3
3 or more	0.7	100.0
Total	100.0	

Source: Nationwide Personal Transportation Study.

Table 10. Percentage of persons in each income group who walk to work.

Household Income ($)	Percent Who Walk to Work	Household Income ($)	Percent Who Walk to Work
Under 3,000	11.9	7,500-9,999	4.5
3,000-3,999	12.7	10,000-14,999	2.9
4,000-4,999	7.0	15,000 and over	3.3
5,000-5,999	5.5	All income groups	5.0
6,000-7,499	5.3		

Source: Nationwide Personal Transportation Study.

Table 11. Percentage of persons classified by occupation who walk to work.

Occupation Group	Percent Who Walk to Work
Professional and semiprofessional	2.8
Managers (farm)	0.0
Other proprietors	3.3
Store and office clerks	5.8
Craftsmen of skilled labor	3.5
Semiskilled	5.5
Protective services	6.4
Personal services	9.1
All occupations	5.0

Source: Nationwide Personal Transportation Study.

Table 12. Percentage of persons who walk to work by age group.

Age	Distribution of Those Walking Only	Distribution of Working Population
16-19	12.4	6.5
20-24	10.5	12.0
25-29	7.0	11.4
30-34	6.9	9.4
35-39	8.1	9.7
40-49	20.6	22.7
50-59	18.9	18.2
60 and over	15.6	10.1
Total	100.0	100.0

Source: Nationwide Personal Transportation Study.

work. This percentage is higher than that reported for the Southwest Washington survey for work trips. This may be related to the distinct separation of residences and employment in Southwest and to possible instability of data from the Southwest survey when analyzing trip length for a single purpose.

Tables 10 and 11 give walking trip distributions by income and occupation respectively. There was a significantly higher proportion of persons with incomes under $4,000 walking than in those income groups over $10,000. By occupation group, professionals or semiprofessionals reported walking to work the least, with those in personal services reporting the highest rate of walking to work.

The distribution of persons walking to work by age group in Table 12 shows higher-than-average walking for the youngest and oldest age groups. Those in the 20-49 age groups reported less than average walking. (Note: If all age groups had the same walking trips per person, the distribution of walking trips would be the same as the distribution of the working population.)

SUMMARY AND CONCLUSIONS

Although based on a small sample, the survey of walking trips in Southwest Washington can be used as an indicator in providing transportation and other community facilities.

Ninety percent of walking trips were less than one mile. This should probably be considered a maximum distance for the provision of facilities to which any walking is anticipated. The median walking trip length was 1,600 ft. This would seem to be a desirable distance within which to provide those services that are visited frequently.

Men made longer walking trip lengths than women; however, this was influenced by the long walking trips to work by some male respondents. If these work trips are excluded, trip lengths would be similar for men and women.

Trip length distributions by age group were different by a chi-square analysis, but the relationship was not clear. The trip length distributions for each age group (Fig. 2) crossed each other several times. This seems to indicate no special consideration for different trip distances by age group.

For all survey days combined, shopping represented the most frequent trip purpose—about 50 percent. The second most frequent trip purpose was for outdoor recreation. Shopping was most frequently for groceries. Outdoor recreation trips were most frequently to the waterfront area along the Potomac River. Because trips are frequent for convenience shopping and recreation, these facilities should be provided within walking distance of residences when possible.

Number of trips per household varied little by development or by housing type. The number of trips per household did not appear to be related to family size.

Unfavorable weather and crime were the most significant factors discouraging walking trips. The attitude toward bicycling for short trips was generally favorable, but many people indicated the desire for separate bikeways.

The Nationwide Personal Transportation Study showed that 5.0 percent of employed persons walk to work. Almost 71 percent walk less than ½ mile to work. There was a higher proportion of walking trips among those in the under $4,000 income groups than in those income groups earning over $10,000 per year. The youngest and oldest working age groups reported higher-than-average walking to work. In developments with high numbers of low-income residents or high numbers of the youngest and oldest working age groups, special consideration should be made for walking.

ACKNOWLEDGMENT

This paper is extracted from a larger study submitted as partial fulfillment of the requirements for the degree of Master of Civil Engineering at Catholic University. The work was completed under the guidance of Dr. Vasant Surti.

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TRAFFIC ENGINEERING FOR PEDESTRIAN SAFETY: SOME NEW DATA AND SOLUTIONS

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This paper describes involvement patterns for a number of specific types of pedestrian accidents. It also describes traffic engineering actions designed to change the behavior of pedestrians and drivers to make them more likely to avoid these specific types of accidents. The patterns and solutions are drawn from a study of over 2,100 individual pedestrian accident cases.

•A GROWING awareness of the nature and extent of the pedestrian safety problem is likely to lead to greater requirements for action by traffic engineers and others to reduce pedestrian casualties. A few facts illustrate the magnitude and trend of the pedestrian problem: Each year there are about 400,000 pedestrian victims, and more than 10,000 of them die. Although the number of fatalities had been slowly decreasing until the late 1950's, the trend has reversed itself and has increased 36 percent since 1958. It has been estimated that there will be about 13,000 pedestrian fatalities in 1980. With improvements in vehicle occupant protection taking place, pedestrians could account for one-third to one-half of highway fatalities by 1980.

TRAFFIC ENGINEERING AND SOLUTION APPROACHES

There are three main approaches to reducing pedestrian casualties. First, we can physically separate the participants and reduce the opportunity for collisions. However, all conflicts cannot be avoided. The second approach is to develop safer behavior so that drivers and pedestrians can avoid accidents. Because this is not likely to be 100 percent effective in the near future, the third approach calls for modifying the impact dynamics, primarily through vehicle design, to reduce the severity of the injury.

This paper is concerned with the second approach. The underlying contention is that traffic engineering can contribute to the development of safe behavior by (a) restricting participants' action possibilities; (b) enhancing their capability to act safely; and (c) enhancing their predisposition or tendency to act safely.

A second underlying contention is that traffic engineering can be most effective when it is part of a comprehensive local pedestrian safety program. The particular focus of this paper is on some specific solutions supported by new data on pedestrian accidents.

METHODOLOGY AND DATA BASE

The methodology and data on which this work is based are reported in detail elsewhere (1). They are only summarized briefly as background for the conclusions.

Data were collected on over 2,100 cases of pedestrian accidents as they occurred during a 10-month period in 13 major cities in the United States. Data were secured by means of interviews with participants and witnesses, on-scene observations, and police records. The focus was on the sequence of events and behavior leading to the accident as well as on selected situational factors that might influence those events. Causal conclusions were drawn for each case individually, and cases were grouped into types primarily on the basis of similarity of causation. Other data were then tabulated for the cases in each type.

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